In this new earthquake springs are said to have burst out on the side of Mount Sipylus. HYDE CLARKE

32, St. George's Square, S.W., August 9

New Biological Term

IN writing certain parts of a book on water-beetles, I find myself frequently desirous of indicating briefly but emphatically that some particular genus I may be mentioning consists of only a single species. If we take a rational or theoretical view of classification rather than an empirical one, it must be admitted that a genus consisting of only one species is almost as great an anomaly as a species that should consist of a single individual; and a special term to indicate the fact would be desirable. Mr. Pascoe has suggested to me that the expression "monotypical genus" meets the want: but I am not satisfied with this, for in the first place it is a phrase, not a word; and in the second place the use of the "typical" interferes with concentration of thought by the introduction of an alien suggestion. I therefore propose to use either the word "autogenus" or the word "monogenus" for the purpose, and on the whole prefer the former. Perhaps some one else may be able to suggest a better term, and I shall be very glad of an expression of opinion on the point.

Thornhill, Dumfriesshire D. SHARP

Depraved Taste in Animals

YOUR correspondent, Mr. Nicols, draws attention this week to what he terms the "depraved taste" for tobacco exhibited by several individuals of that species of Phalangistidæ known as the koala.

Whilst in Australia some years ago I myself remarked the same propensity amongst numerous *wild* specimens of the *Phascolarctos cinereus*, in an abandoned tobacco-clearing not far from my residence, and, like Mr. Nicols, I also observed that no ill effects seemed to follow the consumption of the tobacco by the Koalæ. Now since the Phalangistidæ I had the opportunity of observing were perfectly wild, I cannot agree with Mr. Nicols that their taste for tobacco is a depraved one, although the desire for spirits which he mentions is of course decidedly unnatural.

These observations induced me to make several analyses of the Victorian tobacco, with the result of isolating an hitherto undiscovered vegetable alkaloid. A detailed account of my various experiments is contained in a paper read by me before the Melbourne Medical and Chemical Society, and printed in the fourteenth volume of the Society's *Transactions*.

F. R. GREENWOOD

St. Bartholomew's Hospital, E.C., August 14

Firing a Tallow Candle through a Deal Board

WILL the writer of "Physics without Apparatus" be good enough to specify the conditions of success for the above experiment? C. J. WOODWARD

Birmingham and Midland Institute, August 9

[Set up a ½-inch or ¾-inch plank of deal in the ground. It should be 6–8 inches wide. Ram small charge of gunpowder into gun with wad. Select a *dip* candle just fitting bore; cut down to about 5 inches long, with flat end. Be very particular to ram it down well; for if there is air space between it and the wad there is risk of bursting gun. Take care that the rest of barrel is cleared of bits of tallow. Fire at say 3 yards from plank. If you don't miss aim, there will be a hole *torn*, about 2 inches in diameter.—The WRITER of "Physics without Apparatus."]

$\sqrt{-1}$ must send his name and address.

THUNDERSTORMS[1]

II.

BEFORE I can go farther with this subject it is necessary that I should give some simple facts and illustrations connected with ordinary machine electricity. These will enable you to follow easily the slightly more difficult steps in this part of our subject which remain to be taken.

Since we are dealing mainly with *motion* of electricity, it is necessary to consider to what that motion is due. You all know that winds, *i.e.* motions of the air, are due to differences of pressure. If the pressure were everywhere the same at the same level we should have no winds. Similarly the cause of the motion of heat in a body is difference of temperature. When all parts of a body are at the same temperature there is no change of distribution of heat. Now electricity presents a precisely analogous case. It moves in consequence of difference of *potential*. Potential, in fact, plays, with regard to electricity, a part precisely analogous to the *rôle* of pressure, or of temperature, in the case of motions of fluids and of conducted heat. Now the power of an electrical machine may be measured by the utmost potential it can give to a conductor. The greater the *capacity* of the conductor the longer time will be required for the machine to charge it; but no electricity passes between two conductors charged to the same potential. Hence the power of a machine is to be measured by using the simplest form of conductor, a sphere, and finding the utmost potential the machine can give it. It is easily shown that the potential of a solitary sphere is directly as the quantity of electricity, and inversely as the radius. Hence electricity is in equilibrium on two spheres connected by a long thin wire when the quantities of electricity on them are proportional —not to their surfaces, nor to their volumes, as you might imagine—to their radii. In other words, the capacity is proportional to the radius. This, however, is only true when there are no other conductors within a finite distance. When a sphere is surrounded by another concentric sphere, which is kept in metallic connection with the ground, its capacity is notably increased, and when the radii of the spheres are nearly equal the capacity of the inner one is directly as its surface, and inversely as the distance between the two spheres. Thus the capacity is increased in the ratio of the radius of one sphere to the difference of the radii of the two, and this ratio may easily be made very large. This is the principle upon which the Leyden jar depends.

It is found that the work required to put in a charge is proportional to the square of the charge. Conversely, the damage which can be done by the discharge, being equal to the work required to produce the charge, is proportional to the square of the charge, and inversely to the capacity of the receiver. Or, what comes to the same thing, it is proportional to the square of the potential and to the capacity of the conductor directly. Thus a given quantity of electricity gives a greater shock the smaller the capacity of the conductor which contains it. And two conductors, charged to the same potential, give shocks proportional to their capacities. But in every case, a doubling of the charge, or a doubling of the potential, in any conductor, produces a fourfold shock.

The only other point I need notice is the nature of the distribution of electricity on a conductor. I say *on* a conductor, because it is entirely confined to the surface. Its attractions or repulsions in various directions exactly balance one another at every point in the *substance* of the conductor. It is a most remarkable fact that this is always possible, and in every case in one way only. When the conductor is a single sphere the distribution is uniform. When it is elongated the quantity of electricity per square inch of its surface is greater at the ends than in the middle; and this disproprotion is greater the greater is the ratio of the length to the transverse diameter. Hence on a very elongated body, terminating in a point, for instance, the electric density—that is, the quantity per square inch of surface—may be exceedingly great at the point while small everywhere else. Now in proportion to the square of the electric density is the outward pressure of the electricity tending to escape by forcing a passage

[1] Abstract of a lecture, delivered in the City Hall, Glasgow, by Prof Tait. Continued from p. 341.

through the surrounding air. It appears from experiments on the small scale which we can make with an electrical machine, that the electric density requisite to force a passage through the air increases under given circumstances, at first approximately as the square root of the distance which has to be traversed, but afterwards much more slowly, so that it is probable that the potential required to give a mile-long flash of lightning may not be of an order very much higher than that producible in our laboratories.

But from what I have said you will see at once that under similar circumstances an elongated body must have a great advantage over a rounded one in effecting a discharge of electricity. This is easily proved by trial. [The electric machine being in vigorous action, and giving a rapid series of sparks, a pointed rod connected with the ground was brought into the neighbourhood, and the sparks ceased at once.] In this simple experiment you see the whole theory and practical importance of a lightning conductor. But, as a warning, and by no means an unnecessary one, I shall vary the conditions a little and try again. [The pointed rod was now insulated, and produced no observable effect.] Thus you see the difference between a proper lightning-rod and one which is worse than useless, positively dangerous. There is another simple way in which I can destroy its usefulness, namely, by putting a little glass cap on the most important part of it, its point, and thus rendering impossible all the benefits it was originally calculated to bestow. [The pointed rod was again connected with the ground, but furnished with a little glass cap. It produced no effect till it was brought within four or five inches of one of the conductors of the machine, and then *sparks* passed to it.] You must be strangely well acquainted with the phases of human perversity if you can anticipate what I am now going to tell you, namely, that this massive glass cap, or *repeller*, as it was fondly called, was only a year or two ago taken off from the top of the lightning-rod employed to protect an important public building. [The repeller was exhibited. It resembled a very large soda-water bottle with a neck much wider than the usual form.] From the experiments you have just seen it must be evident to you that the two main requisites of an effective lightning-rod are that it should have a sharp point (or, better, a number of such points, lest one should be injured), and that it should be in excellent communication with the ground. When it possesses these, it does not require to be made of exceptionally great section; for its proper function is *not*, as is too commonly supposed, to parry a dangerous flash of lightning: it ought rather, by silent but continuous draining, to prevent any serious accumulation of electricity in a cloud near it. That it may effectually do this it must be thoroughly connected with the ground, or (if on a ship or lighthouse) with the sea. In towns this is easily done by connecting it with the water mains, at sea by using the copper sheathing of the ship, or a metal plate of large surface fully immersed. Not long ago a protected tower was struck by lightning. No damage was done in the interior, but some cottages near its base were seriously injured. From a report on the subject of this accident it appears that the lower end of the lightning rod was "jumped" several feet into the solid rock! Thus we see, in the words of Arago, how "False science is no less dangerous than complete ignorance, and that it *infallibly* leads to consequences which there is nothing to justify."

That the lightning-rod acts as a constant drain upon the charge of neighbouring clouds is at once proved when there is, accidentally or purposely, a slight gap in its continuity. This sometimes happens in ships, where the rod consists of separate strips of metal inlaid in each portion of the mast. If they are not accurately fitted together, a perfect torrent of sparks, almost resembling a continuous arc of light, is seen to pass between them whenever a thunderstorm is in the neighbourhood.

I cannot pass from this subject without a remark upon the public as well as private duty of having lightning-rods in far greater abundance than we anywhere see them in this country. When of proper conducting power, properly pointed, properly connected with the ground and with every large mass of metal in a building, they afford absolute protection against ordinary lightning—every single case of apparent failure I have met with having been immediately traceable to the absence of one or other of these conditions. How great is their beneficial effect you may gather at once from what is recorded of Pietermaritzburg, viz., that till lightning-rods became common in that town it was constantly visited by thunderstorms at certain seasons. They still come as frequently as ever, but they cease to give lightning-flashes whenever they reach the town, and they begin again to do so as soon as they have passed over it.

A knight of the olden time in full armour was probably as safe from the effects of a thunderstorm as if he had had a lightning-rod continually beside him; and one of the Roman emperors devised a perfectly secure retreat in a thunderstorm in the form of a subterraneous vault of iron. He was probably led to this by thinking of a mode of keeping out missiles, having no notion that a thin shell of soft copper would have been quite as effective as massive iron. But those emperors who, as Suetonius tells us, wore laurel crowns or sealskin robes, or descended into underground caves or cellars on the appearance of a thunderstorm, were not protected at all. Even in France, where special attention is paid to the protection of buildings from lightning, dangerous accidents have occurred where all proper precautions seemed to have been taken. But on more careful examination it was usually found that some one essential element was wanting. The most common danger seems to lie in fancying that a lightning-rod is necessarily properly connected with the earth if it dips into a mass of water. Far from it. A well-constructed reservoir full of water is *not* a good "earth" for a lightning-rod. The better the stonework and cement the less are they fitted for this special purpose, and great mischief has been done by forgetting this.

A few years ago the internal fittings of the lighthouse at Skerryvore were considerably damaged by lightning, although an excellent lightning-rod extended along the whole height of the tower.

The real difficulty in these situations, exposed to tremendous waves, lies in effecting a permanent communication between the lightning-rod and the sea. But when this is done the sea makes far the best of "earths."

When a lightning-rod discharges its function imperfectly, either from insufficient conducting power or because of some abnormally rapid production of electricity, a luminous brush or glow is seen near its point. This is what the sailors call St. Elmo's Fire, or Castor and Pollux. In the records of mountain climbing there are many instances of such discharges to the ends of the alpenstocks or other prominent pointed objects. One very remarkable case was observed a few months ago in Switzerland, where at dusk, during a thunderstorm, a whole forest was seen to become luminous just *before* each flash of lightning, and to become dark again at the instant of the discharge.

Perhaps the most striking of such narratives is one in the memoirs of the Physical and Literary Society of Edinburgh, on Thunder and Electricity, by Ebenezer McFait, M.D.

The destructive effects of lightning are familiar to all of you. All the more ordinary effects can easily be reproduced by the help of Leyden jars on a small scale. How small you may easily conceive when I tell you that a three-foot spark is considered a long one, even from our most powerful machines, while it is quite certain that lightning flashes often exceed a mile in length, and sometimes extend to four and five miles. One recorded observation,

by a trustworthy observer, seems to imply a discharge over a total length of nearly ten miles.

When a tree is struck by a violent discharge it is usually split up laterally into mere fibres. A more moderate discharge may rupture the channels through which the sap flows, and thus the tree may be killed without suffering any apparent external damage. These results are usually assigned to the sudden vaporisation of moisture, and the idea is probably accurate, for it is easy to burst a very strong glass tube if we fill it with water and discharge a jar by means of two wires whose extremities are placed in the water at a short distance from one another. The tube bursts even if one end be left open, thus showing that the extreme suddenness of the explosion makes it act in all directions, and not solely in that of least resistance. When we think of the danger of leaving even a few drops of water in a mould into which melted iron is to be poured, we shall find no difficulty in thus accounting for the violent disruptive effects produced by lightning.

Heated air is found to conduct better than cold air, probably on account of the diminution of density only. Hence we can easily see how it is that animals are often killed in great numbers by a single discharge, as they crowd together in a storm, and a column of warm air rises from the group.

Inside a thundercloud the danger seems to be much less than outside. There are several instances on record of travellers having passed *through* clouds from which, both before and after their passage, fierce flashes were seen to escape. Many remarkable instances are to be found in Alpine travel, and specially in the reports of the officers engaged in the survey of the Pyrenees. Several times it is recorded that such violent thunderstorms were seen to form round the mountain on which they were encamped, that the neighbouring inhabitants were surprised to see them return alive.

Before the use of lightning-rods on ships became general great damage was often done to them by lightning. The number of British ships of war thus wholly destroyed or much injured during the long wars towards the end of the last and the beginning of the present century is quite comparable with that of those lost or injured by gales, or even in battle. In some of these cases, however, the damage was only indirectly due to lightning, as the powder magazines were blown up. In the powder magazine of Brescia, in 1769, lightning set fire to over 2,000,000 lbs. of gunpowder, producing one of the most disastrous explosions on record.

A powerful discharge of lightning can fuse not only bell wires, but even stout rods of iron. It often permanently magnetises steel, and in this way has been the cause of the loss of many a good ship; for the magnetism of the compass-needles has been sometimes destroyed, sometimes reversed, sometimes so altered that the compass pointed east and west. And by the magnetisation of their steel parts the chronometers have had their rates seriously altered. Thus two of the sailor's most important aids to navigation have been simultaneously rendered useless or, what is worse, misleading; and this, too, at a time when, because of clouds, astronomical observations were generally impossible. All these dangers are now, however, easily and all but completely avoidable.

A very singular effect of lightning sometimes observed is the piercing of a hole in a conducting-plate of metal, such as the lead-covering of a roof. In such a case it is invariably found that a good conductor well connected with the ground approaches near to the metal sheet at the part perforated.

(*To be continued.*)

HUMAN HYBERNATION

DR. TANNER is scarcely off the field when another physiological wonder breaks out in the form of a sleeping girl of Grambke, near to Bremen. This young lady lies, it is said, in a profound slumber night and day, resting on her left side and never asking for food, but swallowing liquid food when it is put into her mouth. The trance lasts an average of fifty days, during which time she is pale, but does not lose in weight. Her sleep is not cataleptic in the proper sense of the term, inasmuch as she is sufficiently conscious to swallow, and presents none of the indications of death. She merely sleeps. Instances of this kind are not so uncommon as those of true catalepsy, though some of them are sufficiently remarkable. In the *Transactions* of the Royal Society Dr. W. Oliver has recorded the history of an extraordinary sleeping person named Samuel Chilton of Tinsbury, near Bath, who, on May 13, 1694, being then "of robust habit of body, not fat, but fleshy, and a dark brown hair," happened, without any visible cause or evident sign, to fall into a very profound sleep, out of which no art used by those who were near him could rouse him until after a month's time; then he rose of himself, put on his clothes, and went about his business of husbandry as usual; slept, could eat and drink as before, but spoke not one word till about a month after. In 1696, on the 9th of April, this youth fell off to sleep again, and although a heroic apothecary, Mr. Gibbs, bled him, blistered him, cupped him, and scarified him, he slept on for seventeen weeks, waking up on August 7, not knowing he had slept above a night, and unable to be persuaded he had lain so long, until going out into the fields he found everybody busy getting in the harvest, and then remembered very well that when he fell asleep they were sowing of the barley and oats which he now saw ripe and ready to be cut down. For six weeks of this sleep he had fasted, but after he awoke he went to work in his ordinary way, and continued to work until August 17, 1697, when, after complaining of shivering and cold in his back, and vomiting once or twice, he fell into one of his long sleeps once more, and being visited by Dr. Oliver and many others, was subjected to further bleeding and extremely sharp treatment indeed, but without being roused. So he lay sleeping until November 19, when he awoke, said he "felt very well, thank God," ate some bread and cheese, and dropping off still another time, slept on until the end of January, 1698, and "then waked perfectly well, not remembering anything that happened all this while." He was observed to have lost flesh, but only complained of being pinched by the cold, and presently fell to husbandry as at other times. The known phenomenon that is nearest to this is hybernation in some of the inferior animals; but it is worthy of remark that the persons affected take food unconsciously when it is offered them, the lower nervous centres seeming to remain in a continued state of activity.

PHYSICS WITHOUT APPARATUS[1]

III.

THE laws of the behaviour of liquids, their pressure and their flow, are very readily demonstrated without special apparatus by the aid of simple articles of every-day use. First amongst the laws of liquid pressure comes the all-important principle that the pressure exerted by a liquid at any point is proportional to the depth, below the surface, of the point under consideration. This pressure is exerted upwards or downwards according to circumstances. We can show first a case of pressure exerted in an upward direction. Take the glass chimney of a lamp, that of a paraffin-lamp will answer, though the straighter form of chimney used in an Argand or a Silber lamp is preferable. Cut out with a pair of scissors a circular disk of stout cardboard, and attach a thread to it by means of a drop of sealing-wax. Provide yourself also with a deep dish of water. Such a glass trough as is

[1] Continued from p. 345.